

APPENDIX G

Refined monitoring questions, potential metrics, and estimated monitoring frequency for high ranking Vital Signs in the Great Lakes Inventory and Monitoring Network.

Vital Sign and related Monitoring Questions	Potential Metrics	Frequency of data collection/analysis
Advanced water quality suite:		
1 Are aquatic-dependent biotic communities changing over time? (e.g., fish, zooplankton, aquatic vegetation, crayfish, mussels)	species richness, diversity, community composition, age classes, reproductive success, frequency and % cover by species (vegetation)	annually
2 Are aquatic nuisance species (ANS) populations changing over time? (ruffe, round goby, Eurasian milfoil, zebra mussel, curly pondweed, Bythotrephes, etc.) Are areas of infestation changing over time? Are new ANS invading? More specifically, have Bythotrephes spread to new lakes at PIRO? Have zebra mussels colonized lakes other than x,y,z at SLBE?	abundance and frequency of occurrence, % area covered,	≤ 5 years
3 Is productivity (nutrient levels) changing in a directional manner over time?	especially compounds of N and P, but also Mg, S, Ca, Si, C	monthly or every 2 weeks during ice-off, monthly under ice
4 What are the trends in critical contaminants/pollutants?	selected suite (mercury, PCBs...), look at loads in upper level food chain organisms such as fish, eagles, otter	annually
5 Are E. coli and fecal coliform levels changing over time? Are numbers of beach closing/season changing over time?	colony counts, # days	as needed
6 Are weather patterns and upstream releases predictive of fecal coliform levels at beaches?	date, time, and location of known releases, colony counts at source and at beaches; plot against wind direction, temperature etc.	strategic 5 year project
Core water quality suite: (as per WASO guidelines)		
1 What is the rate and direction of change in water temperature, conductivity, pH, dissolved oxygen, lake levels and/or stream flow in select waterbodies?	water profiles of °C, EC25, pH units, mg/L or % saturation; staff gauges for lake levels; cfs for stream flow	monthly or every 2 weeks during ice-off, monthly under ice

APPENDIX G. CONTINUED

Refined Vital Signs

Terrestrial plants:

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| 1 | How is plant community composition changing over time? | species richness, diversity, frequency & % cover by species, extent of area by type, pattern and fragmentation | biennially |
| 2 | How is the structural composition of the terrestrial plant community changing over time? | age classes, % cover in different layers, density (# stems, basal area), amount of dead/down | biennially |
| 3 | How do plant communities respond to anthropogenic and natural disturbance? | monitor before, during, after disturbance events; record disturbance types, durations; manipulative research | as needed |

Bird communities:

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| 1 | Is avian biological diversity stable, or are components of the community changing over time? | number of individuals, community composition by habitat type, availability of different habitat types | annually |
| 2 | What are the population trends of species of concern? | # individuals, amount of suitable habitat, reproductive success | annually |
| 3 | Are park management practices (human use, habitat change, reintroductions) altering the avian community structure? | community composition by habitat type, amount of different habitat types | annually |

Plant & animal problem species:

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| 1 | What is the rate and direction of population change for targeted problem species? | # individuals | annual |
| 2 | What is the spatial (range) expansion or contraction rate of targeted problem species? | presence/absence, % cover per unit area at different scales | annual |
| 3 | How are exotic species (and the removal of them) changing native species communities? | species richness, diversity, frequency & % cover by species, pattern and fragmentation | annually |
| 4 | Are management efforts to control or eradicate existing exotic species effective over time? | monitor before, during, after for species richness, diversity, frequency & % cover by species | annually |

Threatened & endangered species:

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| 1 | What are the temporal and spatial changes in the health and viability of targeted rare plants? | density, presence/absence in potential habitats, age class structure, index of health or vigor, measure of reproduction (e.g., # seeds set) | annually |
| 2 | How is the reproductive success of Bald eagles changing over time? | number of active nests, number young fledged per nest (contaminants in blood of young could be correlated with contaminant suite) | annually |
| 3 | How is the distribution and abundance of T&E freshwater mussels changing? | number of individuals/unit area and by age class, reproductive success, genetic variability, contaminant loads | every 5 years |
| 4 | What is the long-term trend in gray wolf populations? | abundance, reproductive success, genetic variability, predator/prey cycle | annually |
| 5 | What are the trends in targeted rare and T&E species in relation to habitat? | # individuals per habitat type, change in habitat quantity and quality | every 5 years |
| 6 | What are the changes in abundance and range extent for target species (e.g., Karner Blue butterflies)? | index of abundance (#/unit area), % potential habitat occupied | annually |
| 7 | Are management strategies effective in promoting viable populations of target species (e.g., Karner blue butterflies)? | abundance of different life stages (egg masses, larva, adults) per management area | annually |
| 8 | What is the reproductive success and survival rate of target species (e.g., Piping Plover)? | # nests, # recruited or fledged by unit area (e.g., beach segment) | annually |

Amphibians and reptiles:

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| 1 | What is the rate and direction of change in abundance and recruitment of key amphibian and reptile populations? | # individuals per unit of suitable habitat, proportion that are of recruitment age | annually |
| 2 | To what extent do changes in amphibian and reptile populations correlate with major drivers or stressors such as climate, water quality, or lake levels? | correlation analyses of herpetofauna and drivers/stressors | annually |
| 3 | What proportion of amphibians have deformities and is this proportion increasing or decreasing over time? | presence/absence and type of deformities per number of individuals sampled | annually |
| 4 | What are the temporal and spatial changes in natural and human-caused disturbance to nesting turtles? | # and locations of destroyed nests, # suitable nesting sites vs. those used | annually |

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| 5 | What are the spatial and temporal trends in contaminants in snapping turtle eggs? | contaminant loads per nest (2-3 egg sample) for several sample sites for each park | biennially |
| 6 | What are the temporal and spatial changes in amphibian and reptile range extinctions and expansions? | number of extinctions and expansions for each park and by unit area (e.g., island) within | every 10 years |

Landcover coarse scale:

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| 1 | How does landcover in and adjacent to parks change over time? | most metrics would be determined remotely
land cover classification, % cover, amount of impervious surfaces, spatial pattern of visitor use areas (campsites, trails, boat launches etc.) | every 5 years |
| 2 | Are spatial patterns of landcover in and adjacent to parks changing over time? | fragmentation, patch size and shape, juxtaposition | every 5 years |
| 4 | How does change in landcover alter soil retention, stream flow, and lake levels over time? | landcover metrics plus stream flow and lake levels; correlation analysis | annually |
| 2 | How is the morphometry of rivers changing over time and are these changes correlated with landcover/land use? | stream channel morphometry, runoff rate/volume, road density, land cover classification | every 5 years |
| 5 | How do changes in landcover alter turbidity, temperature regimes, and basic water chemistry? | correlate localized changes in landcover with core suite of water quality parameters | annually |

Landcover fine scale: (see also terrestrial plants)

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| 1 | What is the rate and direction of change for highly dynamic environments? (select sample of dunes, spits, beaches, bluffs, stream channels, high use areas) | size and shape of area, lake levels/boundary, stream flow, climatic data, fine-scale cover, % bare ground, soil type | monthly or annually depending on area |
| 3 | How is forest health changing over time? | by cover type: age class, NIR reflectance, coarse woody debris, surface organic matter, occurrence of pests and disease | < annually |
| 4 | How is the size, shape, and composition of wetlands changing over time? | shape and spatial extent, vegetation type, water levels | biennially |
| 5 | How are campsites changing morphologically and physically over time and with different patterns of use? | soil compaction, % veg cover, erosion/sedimentation, trailing, visitor use patterns (season, numbers) | annually |

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Refined Vital Signs

- 6 How are road systems and road use patterns in and adjacent to parks changing over time?

road density by type (e.g., dirt, paved, 4-lane),
number of vehicles per mile of road by type

annually

Phenology:

- 1 What are the temporal and spatial changes in phenology within and across the network parks?

ice thickness and duration, snow cover, first
bloom of certain species, leaf-off, leaf-on,
extremes

daily during critical
seasons

Weather:

- 1 What are the temporal and spatial trends in weather parameters within and across the network parks?
- 2 How is climate affecting other vital signs within and across network parks?

degree days, mean & extreme temperatures and
precipitation, disturbance events such as wind
events (blow downs), ice storms, floods,
droughts

hourly, daily, monthly,
annually

as above and correlate with other vital signs as
appropriate (e.g., change in plant communities,
water levels, water quality, etc.)

annually